

CLAIMS

What is claimed is:

1. A radio frequency integrated circuit (RFIC) having an antenna diversity structure, the RFIC comprises:

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power amplifier having a first power amplifier section and a second power amplifier section, wherein, when enabled, the first and second power amplifier sections amplify an outbound radio frequency (RF) signal to produce a first amplified outbound RF signal and a second amplified outbound RF signal, respectively, wherein the first amplified  
10 outbound RF signal is provided to a first transformer balun and the second outbound RF signal is provided to a second transformer balun, and wherein the first transformer balun is coupled to a first antenna and the second transformer balun is coupled to a second antenna; and

15 low noise amplifier having a first low noise amplifier section and a second low noise amplifier section, wherein, when enabled, the first low noise amplifier section amplifies a first inbound RF signal to produce a first amplified inbound RF signal, wherein, when enabled, the second low noise amplifier section amplifies a second inbound RF signal to produce a second amplified inbound RF signal, wherein the first inbound RF signal is  
20 received via the first transformer balun and the second inbound RF signal is received via the second transformer balun.

2. The RFIC of claim 1 further comprises:

25 the first low nose amplifier section including a first selectable bias circuit, first AC coupling capacitors, first input transistors, and first load transistors, wherein the first AC coupling capacitors are operably coupled to the first transformer balun and to the first input transistors, wherein the first selectable bias circuit is operably coupled to selectively bias the first input transistors, wherein the first load transistors are operably coupled to  
30 the first input transistors and to loads that provide an output of the low noise amplifier, and wherein the first load transistors are biased via a low noise amplifier bias; and

the second low noise amplifier section including a second selectable bias circuit, second AC coupling capacitors, second input transistors, and second load transistors, wherein the second AC coupling capacitors are operably coupled to the second transformer balun and to the second input transistors, wherein the second selectable bias circuit is operably coupled to selectively bias the second input transistors, wherein the second load transistors are operably coupled to the loads and the second input transistors, and wherein the second load transistors are biased via the low noise amplifier bias.

10     3.     The RFIC of claim 1 further comprises:

the first low noise amplifier section including a first selectable bias circuit, first AC coupling capacitors, first input transistors, and first load transistors, wherein the first AC coupling capacitors are operably coupled to the first transformer balun and to the first input transistors, wherein the first selectable bias circuit is operably coupled to selectively bias the first load transistors, wherein the first load transistors are operably coupled to the first input transistors and to loads that provide an output of the low noise amplifier, and wherein the first input transistors are biased via a low noise amplifier bias; and

20     the second low noise amplifier section including a second selectable bias circuit, second AC coupling capacitors, second input transistors, and second load transistors, wherein the second AC coupling capacitors are operably coupled to the second transformer balun and to the second input transistors, wherein the second selectable bias circuit is operably coupled to selectively bias the second load transistors, wherein the second load transistors are operably coupled to the loads and the second input transistors, and wherein the second input transistors are biased via the low noise amplifier bias.

4.     The RFIC of claim 1 further comprises:

30     the first low noise amplifier section including a first selectable bias circuit, first AC coupling capacitors, and first input transistors, wherein the first AC coupling capacitors

are operably coupled to the first transformer balun and to the first input transistors, wherein the first selectable bias circuit is operably coupled to selectively bias the first input transistors, and wherein the first input transistors are operably coupled to load transistors that are operably coupled to loads that provide an output of the low noise amplifier; and

the second low noise amplifier section including a second selectable bias circuit, second AC coupling capacitors, and second input transistors, wherein the second AC coupling capacitors are operably coupled to the second transformer balun and to the second input transistors, wherein the second selectable bias circuit is operably coupled to selectively bias the second input transistors, wherein the second input transistors are operably coupled to the load transistors.

5. The RFIC of claim 1 further comprises:

the first power amplifier section including an input stage and a first output drive stage, wherein the input stage is operably coupled to amplify the outbound RF signal to produce an intermediate amplified outbound RF signal, wherein the first output drive stage includes input transistors and first output drive transistors, wherein the input transistors are operably coupled to receive the intermediate amplified output RF signal and operably coupled to the first output driver transistors, wherein, when enabled via a first bias voltage, the first output drive transistors provide the first amplified outbound RF signal; and

the second power amplifier section including the input stage and a second output drive stage, wherein the input stage is operably coupled to amplify the outbound RF signal to produce the intermediate amplified outbound RF signal, wherein the second output drive stage includes the input transistors and second output drive transistors, wherein the input transistors are operably coupled to receive the intermediate amplified output RF signal and operably coupled to the second output driver transistors, wherein, when enabled via a

second bias voltage, the second output drive transistors provide the second amplified outbound RF signal.

6. The RFIC of claim 1 further comprises:

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the first power amplifier section including an input stage and a first output drive stage, wherein the input stage is operably coupled to amplify the outbound RF signal to produce an intermediate amplified outbound RF signal, wherein the first output drive stage includes first input transistors and first output drive transistors, wherein, when enabled  
10 via a first input bias voltage, the first input transistors are operably coupled to receive the intermediate amplified output RF signal and operably coupled to the first output driver transistors, wherein the first output drive transistors provide the first amplified outbound RF signal; and

15 the second power amplifier section including the input stage and a second output drive stage, wherein the input stage is operably coupled to amplify the outbound RF signal to produce the intermediate amplified outbound RF signal, wherein the second output drive stage includes second input transistors and second output drive transistors, wherein, when  
20 enabled via a second input bias voltage, the second input transistors are operably coupled to receive the intermediate amplified output RF signal and operably coupled to the second output driver transistors, wherein the second output drive transistors provide the second amplified outbound RF signal.

7. The RFIC of claim 1 further comprises:

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the first power amplifier section including a first input stage and a first output drive stage, wherein the first input section includes AC coupling capacitors, input transistors, first  
output transistors, first loads, and first drive stage AC coupling capacitors, wherein the  
AC coupling capacitors are operably coupled to provide the outbound RF signal to the  
30 input transistors, wherein the input transistors are operably coupled to the first output transistors, wherein the first output transistors are operably coupled to the first loads,

wherein, when enabled via a first bias voltage, the first output transistors provide, in combination with the first loads and via the first driver stage AC coupling capacitors, a first intermediate amplifier outbound RF signal to the first output drive stage, and wherein the first output drive stage provides the first amplifier RF signal; and

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the second power amplifier section including a second input stage and a second output drive stage, wherein the second input section includes the AC coupling capacitors, the input transistors, second output transistors, second loads, and second drive stage AC coupling capacitors, wherein the AC coupling capacitors are operably coupled to provide

10 the outbound RF signal to the input transistors, wherein the input transistors are operably coupled to the second output transistors, wherein the second output transistors are operably coupled to the second loads, wherein, when enabled via a second bias voltage, the second output transistors provide, in combination with the second loads and via the second driver stage AC coupling capacitors, a second intermediate amplifier outbound  
15 RF signal to the second output drive stage, and wherein the second output drive stage provides the second amplifier RF signal.

8. A radio frequency integrated circuit (RFIC) having an antenna diversity structure, the RFIC comprises:

5 a first transformer balun having a first differential signal winding and a first single-ended signal winding, wherein the first single-ended signal winding is operably coupled to a first antenna;

10 a second transformer balun having a second differential signal winding and a second single-ended signal winding, wherein the second single-ended signal winding is operably coupled to a second antenna;

15 power amplifier having a first power amplifier section and a second power amplifier section, wherein, when enabled, the first and second power amplifier sections amplify an outbound radio frequency (RF) signal to produce a first amplified outbound RF signal and a second amplified outbound RF signal, respectively, and wherein the first amplified outbound RF signal is provided to first taps of the first differential signal winding of the first transformer balun and the second outbound RF signal is provided to first taps of the second differential signal winding of the second transformer balun; and

20 low noise amplifier having a first low noise amplifier section and a second low noise amplifier section, wherein, when enabled, the first low noise amplifier section amplifies a first inbound RF signal to produce a first amplified inbound RF signal, wherein, when enabled, the second low noise amplifier section amplifies a second inbound RF signal to produce a second amplified inbound RF signal, wherein the first inbound RF signal is received via second taps of the first differential signal winding of the first transformer balun and the second inbound RF signal is received via second taps of the second differential signal winding of the second transformer balun.

9. The RFIC of claim 8 further comprises:  
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the first low noise amplifier section including a first selectable bias circuit, first AC coupling capacitors, first input transistors, and first load transistors, wherein the first AC coupling capacitors are operably coupled to the second taps of the first differential signal winding of the first transformer balun and to the first input transistors, wherein the first selectable bias circuit is operably coupled to selectively bias the first input transistors, wherein the first load transistors are operably coupled to the first input transistors and to loads that provide an output of the low noise amplifier, and wherein the first load transistors are biased via a low noise amplifier bias; and

the second low noise amplifier section including a second selectable bias circuit, second AC coupling capacitors, second input transistors, and second load transistors, wherein the second AC coupling capacitors are operably coupled to the second taps of the second differential signal winding of the second transformer balun and to the second input transistors, wherein the second selectable bias circuit is operably coupled to selectively bias the second input transistors, wherein the second load transistors are operably coupled to the loads and the second input transistors, and wherein the second load transistors are biased via the low noise amplifier bias.

10. The RFIC of claim 8 further comprises:

the first low noise amplifier section including a first selectable bias circuit, first AC coupling capacitors, first input transistors, and first load transistors, wherein the first AC coupling capacitors are operably coupled to the second taps of the first differential signal winding of the first transformer balun and to the first input transistors, wherein the first selectable bias circuit is operably coupled to selectively bias the first load transistors, wherein the first load transistors are operably coupled to the first input transistors and to loads that provide an output of the low noise amplifier, and wherein the first input transistors are biased via a low noise amplifier bias; and

the second low noise amplifier section including a second selectable bias circuit, second AC coupling capacitors, second input transistors, and second load transistors, wherein the

second AC coupling capacitors are operably coupled to the second taps of the second differential signal winding of the second transformer balun and to the second input transistors, wherein the second selectable bias circuit is operably coupled to selectively bias the second load transistors, wherein the second load transistors are operably coupled to the loads and the second input transistors, and wherein the second input transistors are biased via a low noise amplifier bias.

11. The RFIC of claim 8 further comprises:

the first low noise amplifier section including a first selectable bias circuit, first AC coupling capacitors, and first input transistors, wherein the first AC coupling capacitors are operably coupled to the second taps of the first differential signal winding of the first transformer balun and to the first input transistors, wherein the first selectable bias circuit is operably coupled to selectively bias the first input transistors, and wherein the first input transistors are operably coupled to load transistors that are operably coupled to loads that provide an output of the low noise amplifier; and

the second low noise amplifier section including a second selectable bias circuit, second AC coupling capacitors, and second input transistors, wherein the second AC coupling capacitors are operably coupled to the second taps of the second differential signal winding of the second transformer balun and to the second input transistors, wherein the second selectable bias circuit is operably coupled to selectively bias the second input transistors, wherein the second input transistors are operably coupled to the load transistors.

12. The RFIC of claim 8 further comprises:

the first power amplifier section including an input stage and a first output drive stage, wherein the input stage is operably coupled to amplify the outbound RF signal to produce an intermediate amplified outbound RF signal, wherein the first output drive stage includes input transistors and first output drive transistors, wherein the input transistors



are operably coupled to receive the intermediate amplified output RF signal and operably coupled to the first output driver transistors, wherein, when enabled via a first bias voltage, the first output drive transistors provide the first amplified outbound RF signal; and

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the second power amplifier section including the input stage and a second output drive stage, wherein the input stage is operably coupled to amplify the outbound RF signal to produce the intermediate amplified outbound RF signal, wherein the second output drive stage includes the input transistors and second output drive transistors, wherein the input

10 transistors are operably coupled to receive the intermediate amplified output RF signal and operably coupled to the second output driver transistors, wherein, when enabled via a second bias voltage, the second output drive transistors provide the second amplified outbound RF signal.

15 13. The RFIC of claim 8 further comprises:

the first power amplifier section including an input stage and a first output drive stage, wherein the input stage is operably coupled to amplify the outbound RF signal to produce an intermediate amplified outbound RF signal, wherein the first output drive stage

20 includes first input transistors and first output drive transistors, wherein, when enabled via a first input bias voltage, the first input transistors are operably coupled to receive the intermediate amplified output RF signal and operably coupled to the first output driver transistors, wherein the first output drive transistors provide the first amplified outbound RF signal; and

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the second power amplifier section including the input stage and a second output drive stage, wherein the input stage is operably coupled to amplify the outbound RF signal to produce the intermediate amplified outbound RF signal, wherein the second output drive stage includes second input transistors and second output drive transistors, wherein, when

30 enabled via a second input bias voltage, the second input transistors are operably coupled to receive the intermediate amplified output RF signal and operably coupled to the

second output driver transistors, wherein the second output drive transistors provide the second amplified outbound RF signal.

14. The RFIC of claim 8 further comprises:

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the first power amplifier section including a first input stage and a first output drive stage, wherein the first input section includes AC coupling capacitors, input transistors, first output transistors, first loads, and first drive stage AC coupling capacitors, wherein the AC coupling capacitors are operably coupled to provide the outbound RF signal to the input transistors, wherein the input transistors are operably coupled to the first output transistors, wherein the first output transistors are operably coupled to the first loads, wherein, when enabled via a first bias voltage, the first output transistors provide, in combination with the first loads and via the first driver stage AC coupling capacitors, a first intermediate amplifier outbound RF signal to the first output drive stage, and  
10 wherein the first output drive stage provides the first amplifier RF signal; and  
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the second power amplifier section including a second input stage and a second output drive stage, wherein the second input section includes the AC coupling capacitors, the input transistors, second output transistors, second loads, and second drive stage AC coupling capacitors, wherein the AC coupling capacitors are operably coupled to provide the outbound RF signal to the input transistors, wherein the input transistors are operably coupled to the second output transistors, wherein the second output transistors are operably coupled to the second loads, wherein, when enabled via a second bias voltage, the second output transistors provide, in combination with the second loads and via the  
20 second driver stage AC coupling capacitors, a second intermediate amplifier outbound RF signal to the second output drive stage, and wherein the second output drive stage provides the second amplifier RF signal.  
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